

REMARKS

Applicant wishes to thank the Examiner for the courtesies extended during the November 3, 2006 telephonic discussion and the December 4, 2006 in person interview. During the interview, applicant's representative and the Examiner discussed the outstanding claim rejections, and applicant's proposed claim amendments and remarks in response thereto. The Examiner proposed a claim amendment and indicated that the proposed amendment and applicant's proposed remarks appeared to render the claims allowable over the cited art. The amendments and remarks presented herein are consistent with that discussion.

Applicant acknowledges with appreciation the Examiner's indication during the interview and in the interview summary that claims 112-116 are no longer rejected under 35 U.S.C. § 103(a) over United States Patent 4,524,236 in combination with United States Patents 5,043,461 or 5,439,859. Instead, the Examiner rejected those claims over United States Patent 4,524,236 alone.

Applicant also acknowledges with appreciation the Examiner's withdrawal of the finality of the previous Office Action and the entry of applicant's July 25, 2006 submission.

Applicant further acknowledges with appreciation the Examiner's indication that the terminal disclaimer has been accepted and recorded.

Claims 109-116 are currently pending in the present application. Applicant has amended claim 109 to more particularly define the scope of the present invention. As amended, claim 109 recites that the alkane is fed into a reaction zone comprising alkene and catalyst. This amendment is supported in the specification. See, e.g., specification page 23, lines 4 through page 25, line 23; and Examples 27 and 28.

This amendment does not add new matter.

Applicant requests reconsideration of the present application in view of the foregoing amendment and the following remarks.

THE REJECTIONS

I. Rejections under 35 U.S.C. §102(b)

The Examiner has rejected claim 109 under 35 U.S.C. §103(a), as allegedly being anticipated by United States Patent 4,524,236 ("McCain").

The Examiner asserts that "McCain discloses an oxydehydrogenation process to convert alkanes (e.g., ethane) to alkenes (e.g., ethylene) by contacting the alkanes, in the presence of oxidizing agent, with a catalyst comprising about 0.001 to 1 molar of nickel and a metal such as Nb."* Office Action, pages 3-4. The Examiner further asserts that, "since the

* Applicant explains below how the Examiner's comment that the McCain catalyst contains 0.001 to 1 molar nickel is incorrect.

reaction has a conversion of greater than 60%, the product would have a concentration of alkenes greater than 10% relative to total moles of hydrocarbon.” Ibid. Applicant disagrees for the reasons of record and explained during the interview. Applicant discusses these reasons below.

As discussed during the interview, applicant has amended claim 109 to more clearly recite that the alkane is fed into a reaction zone comprising 10% alkene and a Ni-containing catalyst. Applicant’s invention, defined by amended claim 109, is a method for preparing an alkene from the corresponding alkane using a catalyst comprising nickel in which alkane is fed into a reaction zone comprising at least about 10% of alkene. It was applicant’s discovery that nickel-containing mixed-metal oxide catalysts have activity for selectively converting an alkane to its corresponding alkene even in the presence of substantial amounts of alkene in the reaction zone. This discovery is surprising, particularly with respect to ethane conversion, because ethylene is typically more reactive than ethane. See, e.g., specification page 23, lines 4-21.

As discussed during the interview, McCain does not teach the method of amended claim 109. McCain generally discloses a method for the oxydehydrogenation of ethane to ethylene using a calcined oxide catalyst containing Mo, V, Nb, Sb, and X, where “X” may be nickel oxide. In particular, the McCain method uses a reaction mixture that contains ethane, molecular oxygen and water. Col. 5, lines 8-17. The mixture may also contain other gases, such as, nitrogen, helium, carbon dioxide, and methane, as reaction diluents or heat

moderators. Col. 5, lines 19-21. In the McCain method, the gaseous components of the reaction mixture are uniformly admixed prior to being introduced into the reaction zone.

Col. 5, lines 32-34. In fact, McCain expressly specifies that the feed composition should have less than 5% alkene, stating that the ethane-containing feed is a gas stream that

“can also contain minor amounts of hydrogen, carbon monoxide, and the C₃-C₄ alkanes and alkenes, *less than five volume percent of each*”

See Col.5, lines 1-4 (emphasis added). Thus, McCain does not disclose that alkane is fed into a reaction zone comprising at least about 10% of alkene.

In contrast, claim 109 requires that alkene is fed into a reaction zone comprising at least about 10% of alkene. In particular, the claim recites a method for preparing an alkene from the corresponding alkane using a nickel-containing catalyst in which the reaction zone comprises alkene in a molar concentration of at least about 10%, relative to total moles of hydrocarbon, and alkane is fed into the reaction zone. Thus, the McCain method is distinguishable from claim 109 at least because it does not disclose the presence of alkene in the reaction zone prior to the alkane feed.

The distinction between the McCain method and the method of claim 109 is borne out in the improved performance characteristics, *i.e.*, selectivity and conversion, for the conversion of alkanes to alkenes *even* in the presence of substantial amounts of alkene in the reaction zone. The improved performance characteristics of the claim 109 method is surprising, particularly with respect to ethane conversion, because ethylene is typically more

reactive than ethane. See, e.g., specification page 23, lines 4-21. Because McCain fails to disclose an oxydehydrogenation process in which alkane is fed into a reaction zone comprising alkene in a molar concentration of at least about 10%, relative to total moles of hydrocarbon, it fails to anticipate amended claim 109. Accordingly, applicant requests that the Examiner withdraw the 35 U.S.C. § 102(b) rejection.

II. Rejections under 35 U.S.C. §103(a)

1. The Examiner has rejected claims 110-111 under 35 U.S.C. § 103(a), as allegedly being unpatentable over McCain in view of United States Patent 5,043,461 ("Ramachandran") or United States Patent 5,439,859 ("Durante").

Applicant respectfully submits that claims 110-111 are patentable over McCain in view of Ramachandran or Durante for at least the reasons set forth in applicant's previous Reply and discussed during the interview. Applicant discusses these reasons below.

The combination of McCain and Ramachandran or Durante fails to teach or suggest all the elements of amended claims 110-111. As detailed above, McCain fails to teach or suggest a method for preparing an alkene in which alkane is fed into a reaction zone comprising at least 10% alkene, as required by amended claims 110-111. This failure is in no way cured by the teachings of Ramachandran or Durante.

Ramachandran relates to a process for the production of *alkylene oxides* from alkanes (e.g., conversion of propane to propylene oxide). In the Ramachandran method,

propane is fed into a dehydrogenator where it is converted to *propylene* in the presence of a conventional dehydrogenation catalyst *under non-oxidative conditions*. Col. 6, lines 21-30. The effluent product stream comprising unreacted propane, propylene and hydrogen is then fed into a conventional oxidation reactor along with pure oxygen, air, or preferably oxygen-enriched air and ammonia to produce *propylene oxide*. Col. 6, lines 30-35. The effluent from the oxidation reactor is quenched and introduced under pressure into a conventional absorber/stripper unit. Col. 7, lines 3-15. The absorber/stripper unit produces a waste stream and a recycle stream. Col. 7, lines 31-34. The recycle stream contains unreacted alkane and alkene, as well as a minor quantity of oxygen. Col. 7, lines 35-38. The recycle stream is introduced into a selective oxidation reactor containing an art-recognized catalyst for the selective reaction of oxygen and hydrogen to form water. Col. 7, lines 43-45. Thus, Ramachandran does not teach or suggest a method for preparing an alkene using an oxidative dehydrogenation catalyst, as required by claims 110-111. Nor does Ramachandran teach or suggest that an alkane is fed into a reaction zone comprising at least 10% alkene, as required by claims 110-111.

The Examiner relies on Ramachandran for “teaching that the recycle step of alkene to the oxyhydrogenation reaction zone would increase the overall product efficiency.” Office Action, page 7. As an initial matter, and as discussed during the interview, the passage cited by the Examiner refers to increasing the efficiency of an oxidation reaction, *i.e.*, the oxidation of ethylene to ethylene oxide – which is not the same as applicant’s

oxydehydrogenation reaction. And, further, the skilled artisan would readily acknowledge that this passage would not refer to an oxydehydrogenation reaction because oxydehydrogenation catalysts tend to be product sensitive. This is especially true with respect to ethane conversion because ethylene is typically more reactive than ethane over most catalysts. See, e.g., specification page 23, lines 4-21. Importantly, it was applicant's discovery that nickel containing catalysts have high selectivities and conversions for the conversion of alkane to alkene *even* in the presence of the product alkene.

The failure of Ramachandran and McCain to teach or suggest all the elements of claims 110-111 is not cured by the teachings of Durante. Durante relates generally to catalytic dehydrogenation of alkanes. Col. 1, lines 7-8. In the passage cited by the Examiner at page 6 of the Office Action, Durante relates to a multi-step process for dehydrogenation of alkanes in which alkane and hydrogen mixtures are passed through alternating endothermic catalytic dehydrogenation zones and at least one exothermic catalytic oxidation zone. See, Col. 5, lines 33-35. In the Durante method, alkane-containing feed is contacted with a dehydrogenation catalyst *under non-oxidative conditions* in each of a plurality of dehydrogenation zones to produce hydrogen and dehydrogenated hydrocarbon. Col. 5, lines 28-33. The catalyst employed in the dehydrogenation zones may be a known catalyst for dehydrogenation of alkanes. Col. 6, lines 28-33. Alternatively, the catalyst may be a sulfided catalyst containing nickel and an optional modified such as tin, chromium, copper or other compounds, or a catalyst containing sulfided nickel supported on a carbon coated metal oxide

support. Col. 2, lines 40-51 and 3, lines 57-60. Next, the hydrogen and dehydrogenated hydrocarbon are contacted with an oxidation catalyst and an oxygen-containing gas in each of the oxidation zones to selectively oxidize a portion of the stream and generate heat. Col. 5, lines 40-44. The effluent from each oxidation zone and the generated heat are then routed through another dehydrogenation zone to produce additional hydrogen and dehydrogenated hydrocarbon. Col. 5, lines 44-47. Hydrogen is separated from the reactor effluent in a separate process step using known methods, and a portion of the separated hydrogen is recycled with fresh feed and/or unreacted hydrocarbon feed to a dehydrogenation zone. Col. 5, lines 47-53.

Nowhere does Durante make any mention of preparing an alkene using an oxidative dehydrogenation catalyst, as required by amended claims 110-111. Nor does Durante teach or suggest that an alkane is fed into a reaction zone comprising at least 10% alkene, as required by amended claims 110-111. Thus, Durante, like McCain and Ramachandran, fails to teach or suggest all the elements of claims 110-111.

For at least the reasons above, the combination of McCain and Ramachandran or Durante does not render obvious applicant's claimed invention. Accordingly, applicants request that the Examiner withdraw this rejection under 35 U.S.C. § 103(a).

2. The Examiner has rejected claims 112-116 under 35 U.S.C. § 103(a), as allegedly being unpatentable over McCain.

Applicant respectfully submits that claims 112-116 are patentable over McCain for at least the reasons set forth in applicant's previous reply and discussed during the interview. Applicant discusses these reasons below.

McCain does not disclose or suggest the catalysts used in the methods of amended claims 112-116. In particular, McCain's catalysts have the composition $\text{Mo}_a\text{V}_b\text{Nb}_c\text{Sb}_d\text{X}_e$, where "a" is 0.5 to 0.9, "b" is 0.1 to 0.4, "c" is 0.001 to 0.2, "d" is 0.001 to 0.1 and "e" is 0.001 to 1, where "X" may be nickel oxide. While McCain states that "e" can be 0.001 to 1, it is clear from the minimum values of a, b, c and d that the maximum value of "e" in the composition must be less than 0.4, which is equivalent to a material containing less than about 40% nickel.* In contrast, amended claims 112-116 require a catalyst that includes at least about 0.5 of a nickel-component (*i.e.*, "x" has a value of at least 0.5). Further, McCain only exemplifies a single compound that contains 2% nickel (see, e.g., Example 10). Because McCain fails to teach or suggest using a catalyst that contains at least about 50% of a nickel-component, it fails to render obvious amended claims 112-116.

For at least the reasons above, McCain does not render obvious applicant's claimed invention. Accordingly, applicants request that the Examiner withdraw this rejection under 35 U.S.C. § 103(a).

* The sum of the mole fractions of each component in the McCain catalyst must equal 1, *i.e.*, $a + b + c + d + e = 1$. Solving for e, $e = 1 - (a + b + c + d)$. Using McCain's maximum values of a, b, c and d, $e = 1 - (0.4 + 0.2 + 0.001 + 0.001)$. Thus, the maximum value of e is 0.398.

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CONCLUSION

In view of the foregoing remarks, applicant requests that the Examiner withdraw the claim rejections and allow all claims of this application. If the Examiner believes that an interview would facilitate the resolution of any outstanding issues, he is kindly requested to contact the undersigned.

Respectfully submitted,



Pablo D. Hendler (Reg. No. 40,015)

Nina R. Horan (Reg. No. 47,662)

Attorneys for Applicant

FISH & NEAVE IP GROUP

ROPES & GRAY LLP

Customer No. 46134

1251 Avenue of the Americas

New York, New York 10020-1104

Tel.: (212) 596-9000

Fax: (212) 596-9090